**Working Document Toward**

e-NAV14-10.3.3

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**Preliminary Draft New Recommendation ITU-R M.[VDES][[1]](#footnote-1)\***

Technical characteristics for a VHF Data Exchange System (VDES) in the VHF maritime mobile band

Scope

This Recommendation provides the technical characteristics of a VHF data exchange system (VDES) which includes an integral automatic identification system (AIS) in the VHF maritime mobile band.

The ITU Radiocommunication Assembly,

considering

a) that the International Maritime Organization (IMO) has a continuing requirement for a universal shipborne automatic identification system (AIS);

b) that the use of a universal shipborne AIS allows efficient exchange of navigational data between ships and between ships and shore stations, thereby improving safety of navigation;

c) that a system should be designed using self-organized time division multiple access (SOTDMA) along with other appropriate access schemes and efficient data transmission methods, and sufficient spectrum should be designated, to accommodate all users and meet the likely future requirements for efficient use of the spectrum;

d) that while AIS is used primarily for surveillance and safety of navigation purposes in ship to ship use, ship reporting and vessel traffic services (VTS) applications, a growing need for other maritime safety related communications has developed;

e) that the VHF data exchange system uses integral AIS, gives top priority to AIS, may meet future IMO AIS carriage requirements and also accommodate future expansion in the number of users and diversification of data communications applications, including vessels which are not subject to IMO AIS carriage requirements, aids to navigation and search and rescue;

f) that the VHF data exchange system has data communications capacity and technical characteristics that support IMO plans for both “Modernization of the GMDSS” and “E-Navigation: the harmonized collection, integration, exchange, presentation and analysis of marine information onboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment,”

recognizing

that the implementation of VDES must ensure that the functions of AIS are not impaired;

recommends

**1** that VDES should be designed in accordance with the operational characteristics given in Annex 1 and the technical characteristics given in the Annexes XX (to be draft);

**2** that applications of the AIS which make use of application specific messages (ASM) of the AIS, as defined in Annex 2, should comply with the characteristics given in Annex 4 and should take into account the international application identifier branch, as specified in Annex 4, maintained and published by IMO;

**3** that the design and installation of VDES should also consider relevant technical requirements, recommendations and guidelines published by IMO, IEC and IALA.

Annex 1  
  
Operational characteristics of a VHF Data Exchange System (VDES) in the VHF maritime mobile band

# 1 General

**1.1** The system should give its highest priority to AIS to automatically broadcast ships dynamic and some other information to all other installations in a self-organized manner.

**1.2** The system installation should be capable of receiving and processing all specified digital messages and interrogating calls.

**1.3** The system should be capable of transmitting additional safety information on request.

**1.4** The system installation should be able to operate continuously while under way or at anchor.

**1.5** The system should use TDMA techniques, access schemes and data transmissioin methods in a synchronized manner as specified in the Annexes.

**1.6** The system should be capable of various modes of operation, including the autonomous, assigned and polled modes for the integral AIS.

# 2 VDES functions and frequency usage

VDES functions and frequency usage are illustrated pictorally in Figure 1.

**FIGURE 1**

**VDES Functions and Frequency Usage**

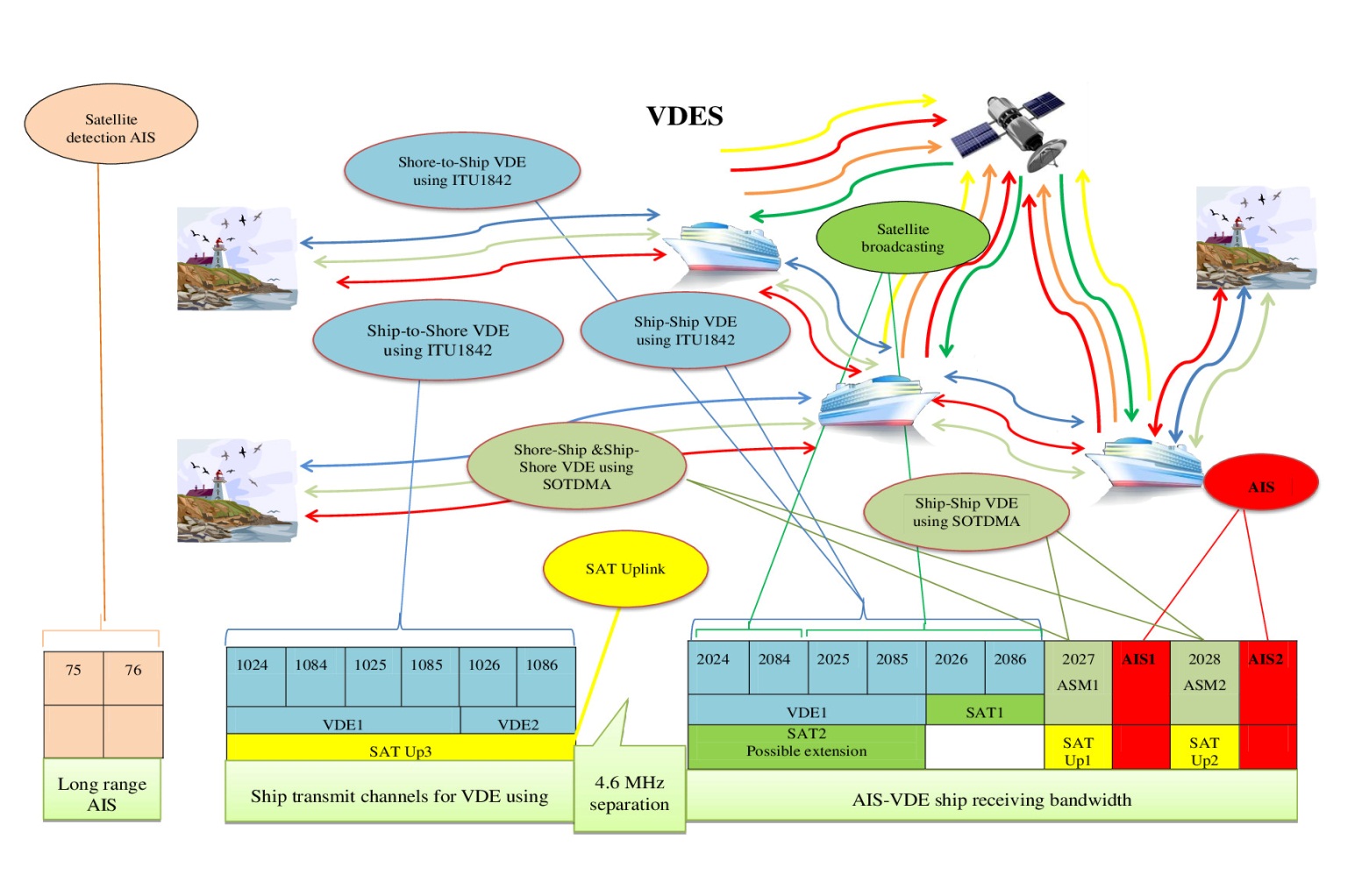


Table 1 describes the RR Appendix 18 channels used for the various applications of VDES.

**Table 1**

**RR Appendix 18 channels used for VDES applications: AIS, ASM, VDE and SAT**

|  |  |  |
| --- | --- | --- |
| Channel number in RR Appendix 18 | Transmitting frequencies (MHz) for ship and coast stations | |
| Ship stations (ship-to-shore)  (long range AIS)  Ship stations (ship-to-satellite) | Coast stations  Ship stations (ship-to-ship)  Satellite-to-ship |
| AIS 1 | 161.975 | 161.975 |
| AIS 2 | 162.025 | 162.025 |
| 75 (long range AIS) | 156.775 (ships are Tx only) | N/A |
| 76 (long range AIS) | 156.825 (ships are Tx only) | N/A |
| 2027 (ASM 1) | 161.950 (2027) | 161.950 (2027) |
| 2028 (ASM 2) | 162.000 (2028) | 162.000 (2028) |
| 24/84/25/85 (VDE 1)  24  84  25  85 | 100 kHz channel  (24/84/25/85, lower legs, merged)  Ship to shore  Ship to satellite | 100 kHz channel  (24/84/25/85, upper legs, merged)  Ship to ship, Shore to ship  Satellite to ship under certain conditions |
| 157.200 (1024) | 161.800 (2024) |
| 157.225 (1084) | 161.825 (2084) |
| 157.250 (1025) | 161.850 (2025) |
| 157.275 (1085) | 161.875 (2085) |
| 26/86 (SAT 1)  26  86 | 50 kHz channel  (26/86, lower legs, merged)  Ship to satellite | 50 kHz channel  (26/86, upper legs, merged)  Satellite to ship |
| 157.300 (1026) | 161.900 (2026) |
| 157.325 (1086) | 161.925 (2086) |

# 3 Identification

Identification and location of all active maritime stations is provided automatically by the AIS. All VDES stations, including satellite stations, should receive AIS messages that identify and locate the source of AIS message transmissions. For the purpose of identification, the appropriate numerical identitfier, e.g. MMSI, should be used, as defined in the latest version of Recommendation ITU-R M.585. Recommendation ITU-R M.1080 should not be applied with respect to the 10th digit (least significant digit). AIS should only transmit if an MMSI is programmed.

# 4 AIS

AIS is an integral part of VDES in shipborne stations, shore base stations and satellite stations. AIS should have the highest priority in the VDES, and all other functions should be organized such that the AIS is not adversely affected and its transmission schedule is not delayed.

## 4.1 AIS VHF data link (VDL) non-controlling stations

## 4.1.1 AIS shipborne station

The integral AIS to the shipborne VDES should conform to requirements for Class A shipborne mobile equipment using SOTDMA technology as described in Recommendation ITU-R M.1371, except that channel switching should not be used.

## 4.2 AIS VDL controlling stations

### 4.2.1 AIS shore base station

The integral AIS to the VDES shore base station should conform to the requirements for AIS base stations as described in Recommendation ITU-R M.1371, except that channel switching should not be used in conjunction with VDES. AIS should have the highest priority of all functions in the VDES shore base station, and all other functions should be organized such that the AIS is not adversely affected and its transmission schedule is not delayed.

# 4.3 Information content for AIS messages

AIS stations should provide static, dynamic and voyage related data as appropriate.

## 4.4 Short safety related AIS messages

Class A shipborne mobile equipment should be capable of receiving and transmitting short safety related messages containing important navigational or important meteorological warning.

Class B shipborne mobile equipment should be capable of receiving short safety related messages.

## 4.5 Information update intervals for the autonomous mode of AIS

The different information types are valid for different time periods and thus need different update intervals.

Static information: Every 6 min or, when data has been amended, on request.

Dynamic information: Dependent on speed and course alteration according to Tables 2 and 3.

Voyage related information: Every 6 min or, when data has been amended, on request.

Safety related message: As required.

**TABLE 2**

Class A shipborne mobile equipment reporting intervals

|  |  |
| --- | --- |
| Ship’s dynamic conditions | Nominal reporting interval |
| Ship at anchor or moored and not moving faster than 3 knots | 3 min(1) |
| Ship at anchor or moored and moving faster than 3 knots | 10 s(1) |
| Ship 0-14 knots | 10 s(1) |
| Ship 0-14 knots and changing course | 3 1/3 s(1) |
| Ship 14-23 knots | 6 s(1) |
| Ship 14-23 knots and changing course | 2 s |
| Ship  23 knots | 2 s |
| Ship  23 knots and changing course | 2 s |
| (1) When a mobile station determines that it is the semaphore (see § 3.1.1.4, Annex 2), the reporting interval should decrease to 2 s (see § 3.1.3.3.2, Annex 2). | |

NOTE 1 – These values have been chosen to minimize unnecessary loading of the radio channels while maintaining compliance within the IMO AIS performance standards.

NOTE 2 – If the autonomous mode requires a shorter reporting interval than the assigned mode, the Class A shipborne mobile AIS station should use the autonomous mode.

**TABLE 3**

Reporting intervals for equipment other than Class A shipborne mobile equipment

|  |  |
| --- | --- |
| Platform’s condition | Nominal reporting interval |
| Class B “SO” shipborne mobile equipment not moving faster than 2 knots | 3 min(1) |
| Class B “SO” shipborne mobile equipment moving 2-14 knots | 30 s(1) |
| Class B “SO” shipborne mobile equipment moving 14-23 knots | 15 s(1), (3) |
| Class B “SO” shipborne mobile equipment moving 23 knots | 5 s(1), (3) |
| Class B “CS” shipborne mobile equipment not moving faster than 2 knots | 3 min |
| Class B “CS” shipborne mobile equipment moving faster than 2 knots | 30 s |
| Search and rescue aircraft (airborne mobile equipment)(4) | 10 s |
| Aids to navigation | 3 min |
| AIS base station(2) | 10 s |
| (1) When a mobile station determines that it is the semaphore (see § 3.1.1.4, Annex 2) the reporting interval (RI) should decrease to 2 s (see § 3.1.3.3.2, Annex 2).  (2) The base station’s RI should decrease to 3 1/3 s after the station detects that one or more stations are synchronizing to the base station (see § 3.1.3.3.1, Annex 2).  (3) The nominal RI for Class B “CS” is 30 s.  (4) Shorter RI down to 2 s could be used in the area of search and rescue operations. | |

**4.6 AIS long range applications**

For the VDES, AIS long range applications should conform to Recommendation ITU-R M.1371. AIS long range broadcast transmissions should use the two channels 75 and 76 designated for “AIS long range” in Table 1.

**5 Application specific messages (ASM)**

For the VDES, to mitigate AIS VDL loading effects, application specific messages (ASM) should conform to the data structure specified in Recommendation ITU-R M.1371 and may use the two channels designated for ASM in Table 1 (ASM 1 and ASM 2) instead of AIS 1 and AIS 2. Selection of the transmission method should consider the comparison of efficiency and performance of the methods shown in Table 4.

**TABLE 4**

**Comparison of AIS and ASM Data Transfer Methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | AIS1 and AIS2  (25 kHz Channels) | Data Transfer Methods  For 25 kHz Channels | | |
| ITU Standard and Digital Modulation | ITU-R M.1371  GMSK | ITU-R M.1842  Annex 1  π/4 DQPSK | ITU-R M.1842  Annex 1  π/8 D8PSK | En 300392-2 v3.2.1 Section 5.11\*  8-OFDM +16-QAM |
| Data Rate | 9.6 kbps (1X) | 28.8 kbps (3X) | 43.2 kbps (4X) | 76.8 kbps (8X) |
| Sensitivity | -107dBm | -107dBm | -107dBm | -107dBm |
| Co-channel rejection (CCR) | 10dB | 19dB | 25dB | 19dB |
| Adjacent channel rejection (ACR) | 70dB | 70dB | 70dB | 70dB |
| AIS Message types | 1, 2, 3, 5, 18, 19 … | 6, 7, 8,12,13,14 … | 6, 7, 8,12,13,14 … | 6, 7, 8,12,13,14 … |
| Rationale | Optimum choice for recurring position reports in a ship-ship navigation safety environment. | Provides high (3X) data transmission. Inferior CCR (+9dB) and range discrimination. | Provides high (4X) data transmission. Inferior CCR (+15dB) and range discrimination. | Highest (8X) data rate for a 25kHz channel (compress multi-slot messages to a single slot). |

**6 VHF data exchange (VDE) Terrestrial**

VHF data exchange (VDE) transmissions should use the channels designated for VDE in Table 1. Selection of the transmission method should consider the comparison of efficiency and performance of the methods and channel bandwidths shown in Table 5. The channel access scheme and transmission timing should conform to Recommendation ITU-R M.1842, Annex 5.

**TABLE 5**

**Comparison of Data Transfer Methods for VDE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | VDE Data Transfer Methods For 25 kHz Channels | VDE Data Transfer Methods  For 50 kHz and 100 kHz Channels | |
| ITU Standard and Digital Modulation | ITU-R M.1842 Annex 1  π/4 DQPSK or π/8 D8PSK  or  En 300392-2 v3.2.1 Section 5.11\* (8-OFDM +16-QAM) | ITU-R M.1842 Annex 3  16-OFDM + 16-QAM | ITU-R M.1842 Annex 4  32-OFDM + 16-QAM |
| Data Rate | 28.8 or 43.2 kbps (3X or 4X)  or  76.8 kbps (8X) | 153.6 kbps (16X) | 307.2 kbps (32X) |
| Sensitivity | -107dBm (ship & shore) | -103dBm (ship stations) | -98dBm (ship stations) |
| Co-channel rejection (CCR) | 19dB or 25dB | 19dB | 19dB |
| Adjacent channel rejection (ACR) | 70dB | 70dB | 70dB |
| Message types | AIS 6, 7, 8,12,13,14 and ASM | VDE messages TBD | VDE messages TBD |
| Rationale | Provides higher (3X or 4X) data transmission than AIS. Inferior CCR (+9dB or +15dB) and range discrimination compared to AIS. | Provides much higher (16X) data transmission than AIS. Inferior CCR (+9dB) and range discrimination compared to AIS. | Provides much higher (32X) data transmission than AIS. Inferior CCR (+9dB) and range discrimination compared to AIS. |

**7 VHF data exchange by satellite (SAT)**

VHF data exchange transmissions by satellite (SAT) should use the channels designated for SAT in Table 1. Selection of the transmission method should consider the comparison of efficiency and performance of the current methods and channel bandwidths. Due to power limitations of satellites and signal power levels required for coordination with terrestrial services, other methods may also be considered as outlined in Annex 2.

Annex 2  
  
Operational and technical characteristics of the VHF data exchange system satellite component

# General

**VHF data exchange system satellite component**

The VHF data exchange satellite component is an effective means to extend the VDES to areas outside of coastal VHF coverage. Hereafter, the satellite component is referred to as the VDE-SAT.

Satellite communications is able to deliver information in a **broadcast**, **multicast** or **unicast** mode to a large number of ships, i.e. efficiently addressing many ships using only minimal radio spectrum resources.

The VDE-SAT will provide a communication channel that is **complementary** to the terrestrial components of the VDES system (i.e. coordinated with terrestrial VHF data exchange (VDE), application specific messages (ASM) and AIS functionalities and their supporting systems).

**Applications**

Continuous exchanges with the maritime community will provide further insight into the priorities, quality of service (QoS), security, integrity and other requirements of future VDES services.

There is a large population of smaller size ships - which have no satellite communication equipment on board, but do have regular VHF/AIS reception equipment – that could benefit from the services mentioned above. This would be of particular benefit for vessel populations in developing countries.

Using low-cost satellite reception technology, VDE-SAT can address a large population of ships and offer services for non-SOLAS vessels, recreational users, life rafts, and even individuals in distress.

# Overall architecture, operational characteristics and assumptions

**Architecture**

The VDE-SAT is composed of one or more satellites transmitting and receiving in the maritime VHF bands – this is the *space segment*.

Due to the frequencies used, it is likely that VDE-SAT will consist of low-earth orbiting (LEO) or medium-earth orbiting (MEO) satellites. VDE-SAT could also consist of hosted payload on spacecraft in such orbits.

Furthermore, the VDE-SAT user terminals will be integrated in ship-borne VDES equipment. This is called the *user segment*. These terminals could be integrated in the terrestrial VDE equipment along with ASM and AIS functionalities. Also VDE-SAT receive-only terminals can be considered: these would provide a very cost-effective means to disseminate maritime information to smaller ships outside terrestrial VHF coverage, for example in developing countries.

Finally, there will be a *ground segment* which consists of one of more ground stations that will send and receive maritime information to/from ships for further processing or dissemination, via the space segment.

**FIGURE 2 VDE-SAT System Archiecture**

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**Operational characteristics**

The VDE-SAT should complement the VDES terrestrial in areas in which no terrestrial VDE coverage is available, i.e. at the high-seas.

The VDE-SAT should provide a communication channel that is coordinated with terrestrial VDE, ASM and AIS functionalities and supporting systems.

The VDE-SAT should provide a downlink capability (i.e. allow to send information from a ground station to one or more ships). Note that VDE-SAT will likely use its specific multicast or broadcast capability which is inherent in satellite downlink.

The VDE-SAT should provide an uplink capability (i.e. allow a ship to send information to the satellite, for further relaying to a ground station).

As VDE-SAT will be based on LEO or MEO satellite(s), provisions will need to be taken for the discontinuous contact that ships will have with individual satellites. Furthermore, if there are multiple VDE-SAT satellites or payload footprints that overlap, some coordination between them may be required.

It is proposed that VDE-SAT supports priority, pre-emption and precedence for different services; this could be mapped into different downlinks.

# Technical characteristics

**VDE-SAT channels and spectrum**

The VDE-SAT downlink should be used for data downlink from the satellite to vessels in a broadcasting, multicasting or unicasting manner. The VDE-SAT should also provide data uplink from vessels to satellites using one or several multiple-access schemes. The data communication exchange via satellite can for example use one of the following methods (as also depicted in the Figure below):



**Figure 3: VDES channel allocation**

1. SAT 1 downlink

The SAT1 downlink frequency spectrum consists of two 25 kHz channels (2026 and 2086). These channels are preferably bundled into one 50 kHz channel to reduce the guard band (needed due to the frequency Doppler shift of incoming signals from LEO satellites), increase the throughput, and more importantly, improve the power efficiency of the satellite power amplifier (avoiding multi-carrier transmission which typically requires a larger output back-off).

The SAT1 signal reception on-board of a ship is likely to be interrupted during the AIS or ASM or VDE1 (terrestrial) transmission by the same ship. The frame structure for SAT1 downlink should be such that to facilitate the signal reacquisition and to minimize the loss of VDE-SAT downlink frames. This can for example be accomplished by coorsinated time allocation or other means to mitigate interference.

Due to the power flux limit imposed on the VDE-SAT downlink (as part of frequency sharing criterion with land mobile), certain level of redundancy (in the form of frame repetition, forward error correction or higher layer redundancy) should be implemented in the VDE-SAT waveform in order to mitigate the error and enhance the data detection probability.

The VDE-SAT downlink waveform should also include repeated known symbols (pilots, preamble, post-amble) to facilitate the signal detection and synchronization as well as possible interference mitigation and channel estimation.

In order to avoid unwanted in-band spectral lines, the data symbols should be scrambled with a known sequence.

1. VDE-SAT Extended Downlink (SAT1 + SAT 2 downlink extension)

At high seas, in the absence of shore-to-ship and ship-to-ship data exchange, the satellite data downlink can be significantly improved by assigning the entire 150 kHz bandwidth (corresponding to the upper frequency allotments of the VDES) to the satellite downlink. This will allow for considerably larger volume of data downlink to ships per each satellite pass in high seas.

The signal level generated by the satellite at the SAT2 frequency range will be kept below the power flux density level limit (i.e. -125 dBW/m2 per 4 kHz) so that there is no harmful interference caused by the satellite downlink on the terrestrial VDE signal sharing the same frequency (ensuring in-band Carrier-to-interference requirements of terrestrial VDE receivers).

It is envisaged that ship-borne receivers with a higher computation capabilities can detect terrestrial VDE and satellite downlink VDE that share the same frequency band.

Within the VDES system further dissemination of the data can be achieved through mesh networking mechanisms where the data received from the satellite is relayed to other users using the terrestrial ship to ship VDE.

1. SAT 3 Uplink

At the high sea, the frequency spectrum corresponding to 6 lower VDE channels (starting from Channel 1024) will be used for satellite data uplink. Compared to the AIS channels, and long range AIS, these 6 channels with a contiguous bandwidth of 150 kHz provide a significant data uplink capability via satellite.

The access scheme protocol for data uplink via satellite will be carefully designed to take into account multiple self-organized networks within the satellite field of view and to maximize the probability of message detections by avoiding message collisions or devising methods to resolve the collisions.

To avoid any coordination with terrestrial services, the satellite data uplink will only be used out of VDES coastal coverage.

Similar to satellite based reception of AIS1 and AIS2 channels, the ship-borne data on channels 2027 and 2028 can be detected by satellite purely in a reception mode (without satellite component making any intervention in SOTDMA network organization). A detection performance similar or improved compared to the current SAT-AIS is expected.

**Rationale of channel allocation for VDE-SAT**

The frequency plan for the entire VDES, as depicted in Figure 3 above, facilitates a realistic implementation of the proposed system in co-existence with and complementing the current AIS. The following points regarding the proposed frequency plan should be highlighted:

1. The requirements for VDES (together with the existing AIS) concentrate the reception frequencies on board of the ship to a limited range of 250 kHz at the upper maritime VHF band. This will allow an efficient implementation of VDES/AIS on-board receivers by narrowing the input filter bandwidth, reducing potential impairments due to other activities within the maritime VHF band.
2. The VDE-SAT downlink will be hosted within the same frequency range as the terrestrial VDE and AIS. This allows sharing the same antenna as well as the receiver front-end design.
3. Satellite and shore reception frequencies of ship-born VDE signals occupy the lower end of the VHF maritime band. This will allow for a complementary service close to the shore and at the high sea while sharing the same spectrum. The frequency separation between the upper and lower spectra (with 4.45 MHz separation) will allow acceptable level of isolation between VDES/AIS receiving chain and the VDE ship-borne transmitters.
4. The frequency separation between SAT1/SAT2 and SAT3 will allow hosting VDE-SAT transmitter and receiver on the same satellite which allows for a more cost-effective satellite mission concepts (i.e. reduce number of satellites, improved efficiency and possible interactivity).

Annex 3  
  
Abbreviations in use in this Recommendation

ACK Acknowledge

AIS Automatic identification system

AIS-SART AIS Search and Rescue Transmitter

ASCII American standard code for information interchange

AtoN Aid to navigation

BR Bit rate

BS Bit scrambling

BT Bandwidth – Time

CHB Channel bandwidth

CHS Channel spacing

CIRM International Maritime Radio Association (*Comité International Radio Maritime*)

COG Course over ground

CP Candidate period

CRC Cyclic redundancy check

CS Carrier sense

CSTDMA Carrier sense time division multiple access

DAC Designated area code

DE Data encoding

DG Dangerous goods

DGNSS Differential global navigation satellite system

DLS Data link service

DSC Digital selective calling

DTE Data terminal equipment

ECDIS Electronic chart display and information system

ENC Electronic navigation chart

EPFS Electronic position fixing system

ETA Estimated time of arrival

FATDMA Fixed access time-division multiple access

FCS Frame check sequence

FEC Forward error correction

FI Function identifier

FIFO First-in, first-out

FM Frequency modulation

FTBS FATDMA block size

FTI FATDMA increment

FTST FATDMA start slot

GLONASS Global navigation satellite system

GMDSS Global maritime distress and safety system

GMSK Gaussian filtered minimum shift keying

GNSS Global navigation satellite system

GPS Global positioning system

HDG Heading

HDLC High level data link control

HS Harmful substances

HSC High speed craft

IAI International application identifier

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities

ICAO International Civil Aviation Organization

ID Identifier

IEC International Electrotechnical Commission

IFM International function message

IL Interleaving

IMO International Maritime Organization

ISO International Standardization Organization

ITDMA Incremental time division multiple access

ITINC ITDMA slot increment

ITKP ITDMA keep flag

ITSL ITDMA number of slots

ITU International Telecommunication Union

kHz Kilohertz

LME Link management entity

LSB Least significant bit

MAC Medium access control

MAX Maximum

MHz Megahertz

MID Maritime identification digits

MIN Minimum

MMSI Maritime mobile service identity

MOD Modulation

MP Marine pollutants

MSB Most significant bit

NI Nominal increment

NMNautical mile

NRZI Non return zero inverted

NS Nominal slot

NSS Nominal start slot

NTS Nominal transmission slot

NTT Nominal transmission time

OSI Open system interconnection

PI Presentation Interface

ppm Parts per million

RAI Regional application identifier

RAIM Receiver autonomous integrity monitoring

RATDMA Random access time-division multiple access

RF Radio frequency

RFM Regional function message

RFR Regional frequencies

RI Reporting interval(s)

ROT Rate of turn

RR Radio Regulations

Rr Reporting rate (position reports per minute)

RTA RATDMA attempts

RTCSC RATDMA candidate slot counter

RTES RATDMA end slot

RTP1 RATDMA calculated probability for transmission

RTP2 RATDMA current probability for transmission

RTPI RATDMA probability increment

RTPRI RATDMA priority

RTPS RATDMA start probability

Rx Receiver

RXBT Receive BT-product

SAR Search and rescue

SI Selection interval

SO Self organized

SOG Speed over ground

SOTDMA Self organized time division multiple access

TDMA Time division multiple access

TI Transmission interval

TMO Time-out

TS Training sequence

TST Transmitter settling time

Tx Transmitter

TXBT Transmit BT-product

TXP Transmitter output power

UTC Coordinated universal time

VDL VHF data link

VHF Very high frequency

VTS Vessel traffic services

WGS World geodetic system

WIG Wing in ground

1. \* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the International Electrotechnical Commission (IEC) and the Comité International Radio Maritime (CIRM). [↑](#footnote-ref-1)